

Space Weather Technical Forecast

Issued on Tuesday, 19 December 2023 at 13:30 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of isolated M-class flares throughout. Slight chance of G1 intervals.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar Activity is Low, with the peak flare a C7.3 event at 19/0304 UTC from AR3528. Ten sunspot regions feature on the visible disc. AR3529 in the southeast is the largest, with continued growth in penumbral extent observed. AR3526 and AR3528 are two notable spots in the northeast, with slight increase in areal extent and proliferation of intermediate spots. The new region which has rotated around the northeast limb appears moderately large with opposite polarity leader and trailer portions, but is difficult to analyse completely due to foreshortening. AR3519 in the southwest has developed a beta-gamma magnetic complexity, but otherwise remains largely unchanged. All other spots are small and simple.

No new Earth-directed CMEs have been observed in coronagraph imagery.

Solar Wind / Geomagnetic Activity: The solar wind environment was characterised by previous CME influences, followed by the onset of a HSS from CH82/+ late in the UTC day on 18 Dec. Solar wind as measured by ACE at L1, rose from slightly elevated to strong, with a peak of around 700km/s at around 19/0630 UTC. Density fell from largely average to below average through the period. The IMF was mostly moderate initially with a peak of 12nT at 18/1930 UTC, before falling to weak from 18/2300 UTC onward. The north-south component varied +10/-10 nT until following a weakening trend similar to the IMF and becoming largely positive. The magnetic field was mostly positive (away from the Sun). Resultant geomagnetic activity was largely Quiet to Unsettled (Kp 1-3), but with a G1 (Kp5) interval from 18/2100-2400 UTC.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels.

GOES16 high energy (greater than 2MeV) electron flux was mostly at Normal Background levels. The 24-hour fluence was well below the Active threshold (1e8 integrated pfu) on a mostly stable trend. The observation at 19/0000 UTC was 1.24e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low with a chance of becoming Moderate with isolated M-class flares. The greatest risk of significant flares is currently from AR3528 and AR3529.

Solar Wind / Geomagnetic Activity: A weak CME arrival is possible later day 1 or early day 2 (19 or 20 Dec). Solar winds are currently Strong due to the high speed stream of coronal hole 82. This connection is expected to continue through to the middle of the week with speeds waning to Elevated or Slightly Elevated levels. From day 3 (21 Dec), there is a chance of the arrival of the high speed stream from coronal hole 83, with Elevated or Strong solar winds speeds seen at Earth once again, before a gradual relaxation back to Slightly Elevated or Slow-Ambient levels later day 4 (22 Dec) or beyond.

Geomagnetic activity should remain largely Quiet to Unsettled, with a chance of Active conditions and a slight chance of a G1/Minor storm interval upon the arrival of a weak CME day

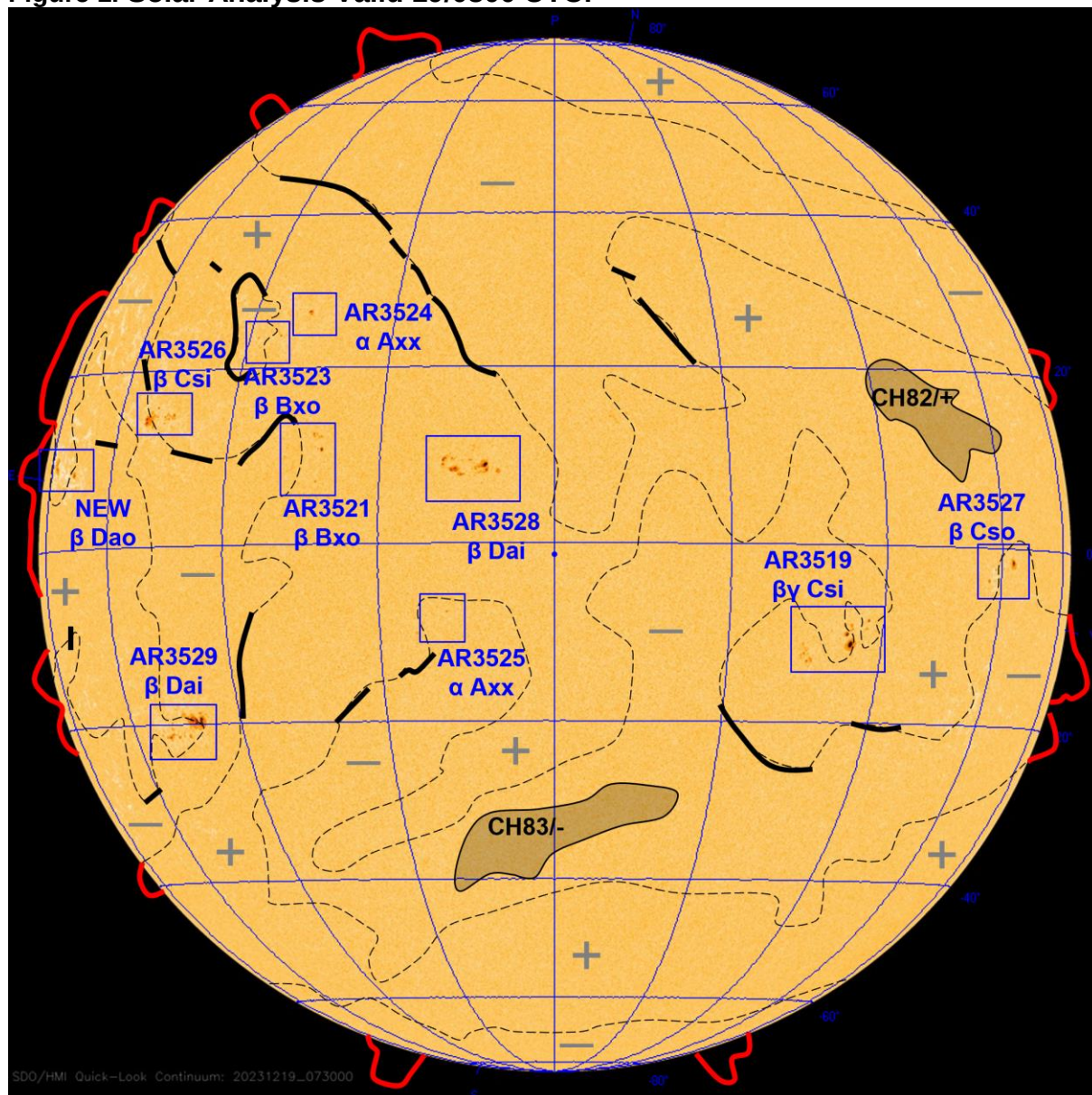
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1 or day 2 (19/20 Dec), or the high speed stream day 3 or day 4 (21/22 Dec).

Energetic Particles / Solar Radiation: GOES16 high energy proton flux is at Background levels and expected to remain at similar levels unless any significant flaring occurs.

High energy electron flux is currently mostly at Normal Background levels and is expected to remain so early in the period, due to the fast wind from CH82/+ and a potential CME 19-20 Dec. Daily High electron levels may be achieved later day 2 or day 3 (20 or 21 Dec) before the HSS from CH83/- likely suppresses electrons once again. Active electron fluence is considered very unlikely throughout.

Figure 1. Solar Analysis Valid 19/0800 UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There is one potentially Earth-directed CME in the forecast, resulting from the 15/2100 UTC south-centre disc filament eruption. This is low confidence due to a weak signal in coronagraph imagery and faster solar winds presently than expected. Although rather uncertain, given the CME's central position, Earth impacts are considered likely but probably muted.

Enhanced solar winds from CH82/+ have reached strong levels. Speeds have now seemingly peaked and should wane back to Elevated or Slightly Elevated levels days 1 and 2 (19/20 Dec). The next potential HSS enhancement is from CH83/- on day 3 or 4 (21/22 Dec). This is a recurrent feature, however, solar wind parameters that correspond with an equivalent time period on the previous rotation (24-25 Nov) do not indicate a strong connection to this feature. Instead, two notable CME arrivals heavily influence that particular period, meaning that any HSS influence is significantly masked. Conversely this feature appears larger and darker than previous rotation therefore may allow solar wind speeds to be faster than previously observed. Given the coronal hole's southerly location on the disc and proximity to the solstice, any geomagnetic effects should be small with limited or negligible enhancements.

Geomagnetic activity should remain largely Quiet to Unsettled, with a chance of Active conditions and a slight chance of a G1/Minor storm interval upon the arrival of a weak CME on day 1 or 2 (19/20 Dec), or the high speed stream of CH83/- days 3 or 4 (21/22 Dec).

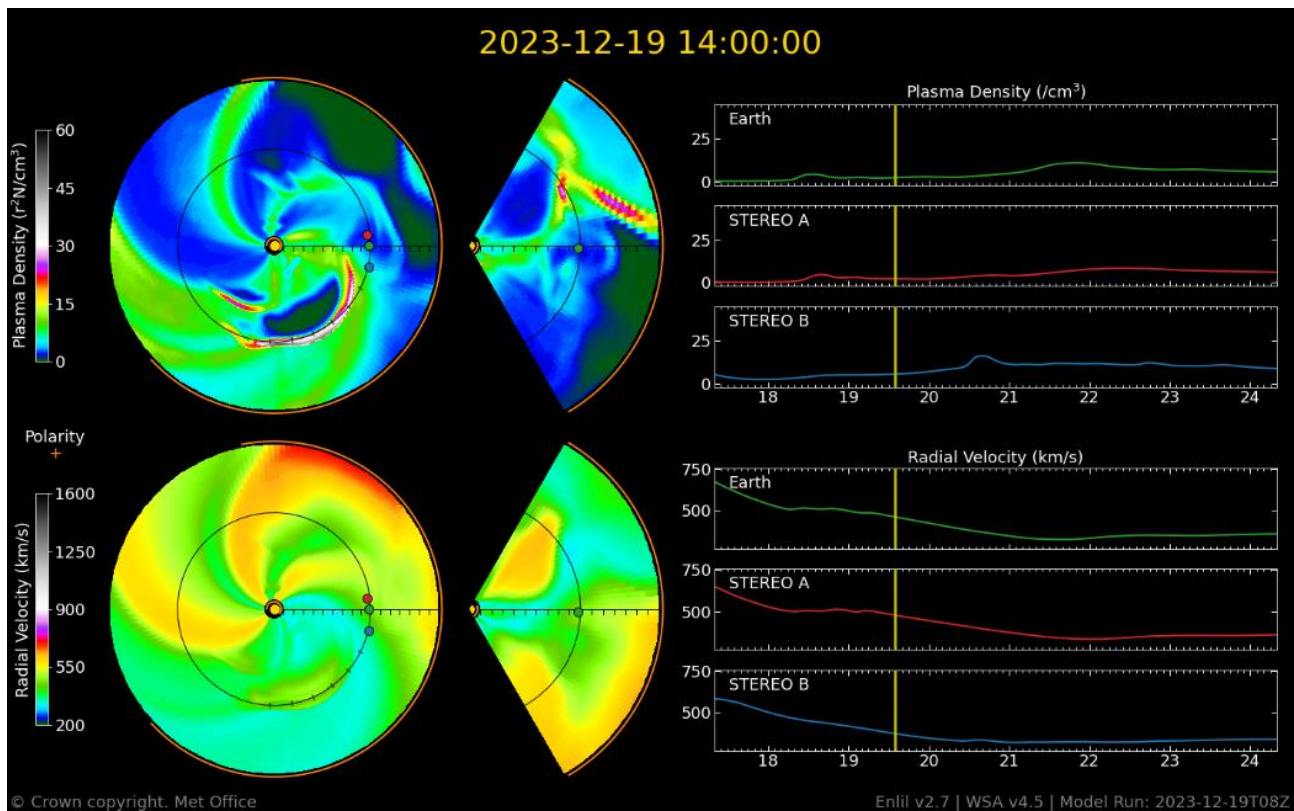
Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	Yes	20	10	20	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
16/1947	Partial	Filament Eruption	S Centre	341 km/s	Late 19 or early 20 Dec	Low confidence

Figure 2: ENLIL

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Radio Blackouts - X-Ray Flares:

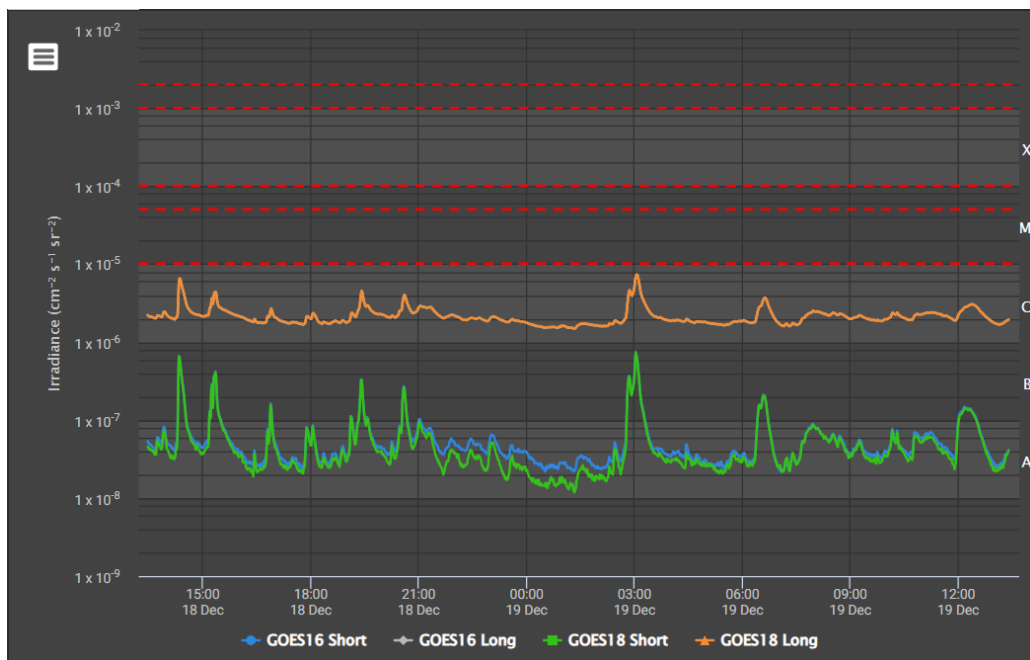
Although current activity is Low, there remains a daily chance of isolated M-class flares.

Ten sunspot regions feature on the visible disc. AR3529 in the southeast is the largest, with continued growth in penumbral extent observed. AR3526 and AR3528 are two notable spots in the northeast, with slight increase in areal extent and proliferation of intermediate spots. The new region which has rotated around the northeast limb appears moderately large with opposite polarity leader and trailer portions, but is difficult to analyse completely due to foreshortening. AR3519 in the southwest has developed a beta-gamma magnetic complexity, but otherwise remains largely unchanged. All other spots are small and simple.

Several new or returning sunspot regions are expected to appear over the eastern solar horizon in the period, however far-side soundings and limb EUV flux are not readily backed up by CME and dimming evidence to suggest any overly active regions.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	35	35	35	35
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: 24 hour X-ray trace



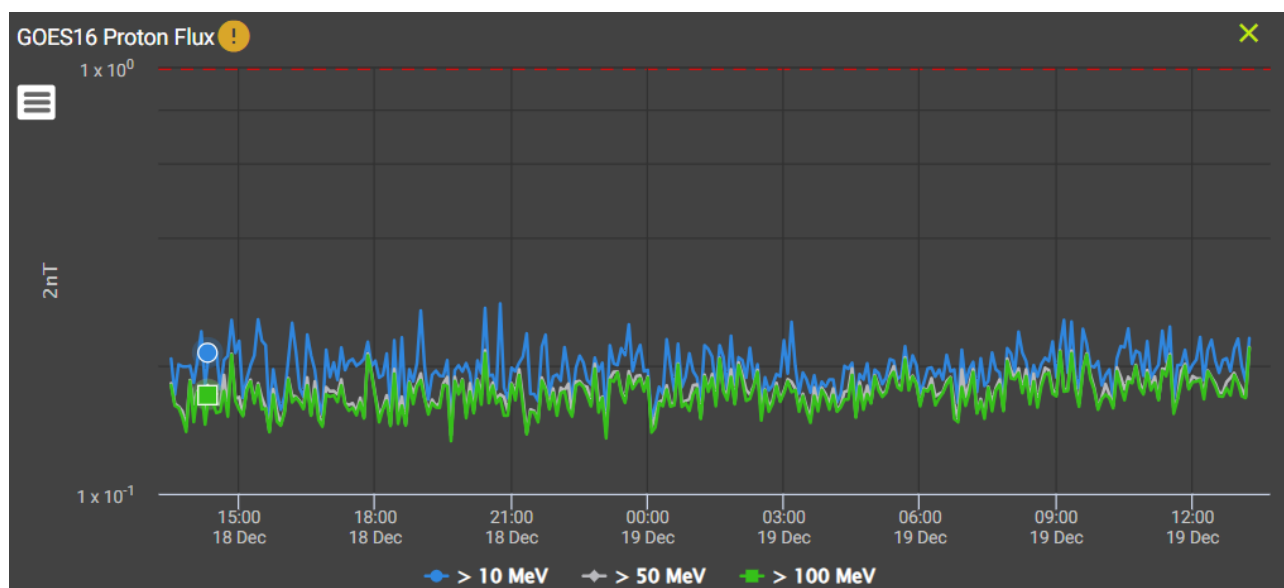
Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is now at normal Background levels and expected to remain at similar levels unless any significant flaring occurs.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 [*]	No	1	1	1	1

^{*} S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)

Figure 4: 24 hour proton flux



High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux is currently mostly at Normal Background levels and is expected to remain so early in the period, due to the fast wind from CH82/+ and a potential CME 19-20 Dec. Daily High electron levels may be achieved later day 2 or day 3 (20 or 21 Dec) before the HSS from CH83/- likely suppresses electrons once again. Active electron fluence is considered very unlikely throughout.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	1	5	5
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: MOSWOC REFM

